DOCUMENT RESUME

ED 202 507 JC 810 272

AUTHOR Frerichs, Allen H.; Eldersveld, Paul J.
TITLE Predicting Successful and Unsuccessful Developmental Mathematics Students in Community Colleges.
PUB DATE Apr 81
NOTE 21p.; Paper presented at the Annual Meeting of the American Educational Research Association (Los Angeles, CA, April 13-17, 1981).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; *Academic Failure; Age; Cognitive Style; Community Colleges; Conventional Instruction; Correlation; Females; Individualized Instruction; Knowledge Level; Literature Reviews; Males; *Predictor Variables; *Remedial Mathematics; Student Attitudes; Student Educational Objectives; Two Year Colleges; *Two Year College Students

ABSTRACT

A study involving 513 developmental math students at eight Illinois community colleges was conducted to determine the correlation between student success or failure in developmental math courses and nine independent variables: (1) instructional method, i.e. "traditional," in which the instructor sets the pace for learning, and "nontraditional," in which students set the pace for learning; (2) cognitive style; (3) numerical skills; (4) age; (5) sex; (6) students' assessment of their math knowledge; (7) student attitudes toward math; (8) students' assessment of their math ability; and (9) their reasons for taking developmental courses. During the study, students were divided into traditional and nontraditional groups and were administered two tests: the Group Embedded Figures Test to identify cognitive style and Form H of the Career Planning Program to assess numerical skills. Data for the remaining independent variables were gathered in a student survey. Stepwide multiple discriminant analysis was used to determine those variables which discriminated between passing and failing students at a .10 level of significance. Study results identified five significant variables indicating that the successful student was more likely to have higher numerical skills, be in a traditionally taught course, be older, have higher perceptions of his/her math abilities, and have more positive attitudes toward math. A literature review is included. (JP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED202507

PREDICTING SUCCESSFUL AND UNSUCCESSFUL DEVELOPMENTAL MATHEMATICS STUDENTS IN COMMUNITY COLLEGES

Allen H. Frerichs
Professor of Educational Psychology
Department of Learning and Development
Northern Illinois University
DeKalb, Illinois

Paul J. Eldersveld
Mathematics Faculty
College of DuPage
Glen Ellyn, Illinois

JC 810 272

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Paul J. Eldersveld

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☒ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Predicting Successful and Unsuccessful Developmental Mathematics Students in Community Colleges

Allen H. Frerichs
Professor of Educational Psychology
Department of Learning and Development
Northern Illinois University
DeKalb, Illinois

Paul J. Eldersveld
Mathematics Faculty
College of DuPage
Glen Ellyn, Illinois

Abstract

This study identified variables that discriminated between successful and unsuccessful students (N = 513) in developmental mathematics in eight Illinois community colleges.

A discriminant analysis indicated that numerical skills, instructional method, age, self-perception of math knowledge and attitudes toward math were in descending order the discriminating variables. Descriptively, the successful students, when compared with the unsuccessful students, were more likely to be enrolled in a lecture-discussion class, scored significantly higher on the numerical skills test, were older, and had better attitudes toward mathematics.

Presented at the
Annual Meeting of the
American Educational Research Association
Los Angeles, California
1981

Predicting the Success and Failure of Community College Developmental Mathematics Students

Purpose of the Study

The purpose of this study was to identify variables which could be used to discriminate between successful and unsuccessful students in developmental mathematics courses in community colleges.

Background

Monroe (1972) has indicated that three traditions have manifested themselves in American public education: (1) universal opportunity, (2) local control and support, and (3) a relevant curriculum. In community colleges, these traditions are manifested in a comprehensive curriculum, an open door admission policy (Gleazer, 1968), and a diverse student body (Medsker, 1960). As a result, more than 90 percent of all community colleges in the United States offer some form of developmental (remedial) mathematics (Baldwin, 1977).

Reactions to community college developmental programs have been mixed. Roueche (1973), Pepper (1978), and Zwerling (1977) have provided evidence to show that developmental programs have remediated student deficiencies in academic performance and level of self-concept. However, their claims for success are tempered in that

these successes seem to be localized, and in that more than 75 percent of the schools do not evaluate their programs (Baldwin, 1977).

However, Craig (1975), Moore (1976), and Losak (1972) found that developmental programs have not been very successful. Their findings indicated that students in developmental programs experienced no greater gains than comparable nondevelopmental students.

Several researchers have attempted to determine which variables are associated with success and failure in developmental mathematics courses. Kimes (1973) reported that intelligence, self-concept, age, and reason for taking the course significantly differentiated successful and unsuccessful students. In a multivariate study, Edwards (1977) found that high school grade average, precourse mathematics achievement, mathematics interest, and attitude toward mathematics were among the best predictors of success. Finally, Dahlke (1974) using discriminant analysis, found that precourse achievement in arithmetic, age, reason for taking the course, and desiring the course for review significantly discriminated between success and failure.

Two additional variables appeared to hold promise as discriminators: instructional style and cognitive style. Developmental mathematics is taught using a variety of instructional procedures, though two procedures predominate. First, the traditional method is a teacher-centered, lecture-discussion class in which the teacher establishes the pace for learning and testing. The nontraditional

method is student-centered in that students set their pace for learning and testing. Available data (Bloomberg, 1971 and Corn and Behr, 1975) showed that the rate of success was lower in non-traditional courses.

Cognitive style has received increased attention as a possible discriminator between success and failure. Goodenough and Witkin (1977) pointed out that people learn in different ways. Field dependent learners tend to rely on external referents and tend to adopt a spectator role. However, field independent learners tend to rely on external referents and tend to adopt a participant role. Thus, it was hypothesized that instructional style and the cognitive style of field dependence-independence are related to success and failure in developmental mathematics courses.

Method

Based on a review of the related literature, the following independent variables were selected as potential discriminators: (1) instructional method, (2) cognitive style, (3) numerical skills, (4) age, (5) sex, (6) self-assessment of knowledge of mathematics, (7) self-assessment of attitude toward mathematics, (8) self-assessment of mathematical ability, and (9) reason for taking developmental mathematics. The dependent variable was success or failure in the developmental mathematics course.

To obtain data for the variable of instructional method, operational definitions were used to divide the entire group (N = 513) into two subgroups: traditional instruction (N = 250) and nontraditional instruction (N = 263). The fundamental difference between the two groups was that in the traditional group, the instructor provided the pacing and organization for testing and learning, while in the nontraditional group, the students provided their own pacing and organization for testing and learning.

Data on the variable of cognitive style were gathered by using the Group Embedded Figures Test (Oltman, 1971) and numerical skills was assessed by the numerical skills section of Form H of the Career Planning Program (1976). A personal data sheet was utilized to obtain data on the remaining independent variables. Finally, data on the dependent variable, success or failure, were obtained from student records. Subjects were successful if they earned a passing grade (A, B, C, D, S, P) within one and one-half terms of registration for the course. All others were classified as unsuccessful.

A discriminant analysis was used to test the following null hypothesis: instructional method, cognitive style, numerical skills, age, sex, self-assessment of knowledge of mathematics, self-assessment of attitude toward mathematics, self-assessment of mathematical ability, and reason for taking developmental mathematics will not discriminate between success and failure in developmental mathematics courses.

Results

Data from a descriptive analysis were used to characterize the population. Using the criteria of the study, the total population (N = 513) was divided into two groups: traditional instruction (N = 250) and nontraditional instruction (N = 263). (In the entire group 65 percent (N = 334) were successful. In the traditional group 72 percent (N = 181) were successful as compared to a success rate of 58 percent (N = 153) in the nontraditional group.)

On the Group Embedded Figures Test, the students scored strongly toward field dependence. The mean score of the total group was 8.51 (SD = 4.94) with the successful subjects scoring a mean of 8.79 (SD = 5.00) and the unsuccessful subjects a mean of 7.99 (SD = 4.79). Witkin (1971) reported a mean score of 12.0 (SD = 4.1) for men and for women 10.8 (SD = 4.2) with lower scores indicating a tendency towards field dependence. However, Witkin's population was a sample of students in a private liberal arts college.

Results from the numerical skills section of Form H of the Career Planning Program indicated that the population scored at the 40th percentile based on normative data supplied by the American College Testing Program (1977). The mean score for successful subjects was higher than for unsuccessful subjects.

Data on the remaining independent variables were obtained from a personal data sheet. As to subject sex, 46 percent (N = 236) were females and 54 percent (N = 277) were males. In each of the instruction

groups, 54 percent of the males were successful as compared to 46 percent of the females. The mean age of the population was 22.81 (SD = 7.51). In each instruction group, the successful students, as a group, were nearly two years older than their unsuccessful counterparts.

Subjects were asked four questions which reflected their perceptions of mathematics. When asked to assess their mathematical knowledge, more than 68 percent of the subjects reported they had already taken a similar course. Furthermore, more than 70 percent expressed a negative or neutral attitude toward mathematics. When asked to judge their mathematical ability, over 90 percent said their mathematical ability was average or lower. Finally, the subjects were asked to state a reason for taking the course. More than 50 percent responded by stating they they are not sure, may need the course, or need to increase mathematic knowledge. This seemed to indicate that many of the subjects lacked a compelling reason for taking the course.

Stepwise discriminant analysis was used to test the hypothesis. To obtain a list of discriminating variables and related data, a discriminant analysis was performed using a default value of $F \geq 1$. The F value was used to test the statistical significance of the amount of separation between the groups added to by the variable used at any given step. Secondly, each variable was examined to determine its contribution to the discrimination. Rao's V was used as the criterion, and the significance was tested using a chi-square

distribution. All variables with a significance level greater than 0.10 were not considered to be discriminating variables.

Five variables were identified as discriminators between successful and unsuccessful students: numerical skills, instructional method, age, self-assessment of knowledge of mathematics, and self-assessment of attitude toward mathematics. Since five variables were shown to discriminate between the successful and unsuccessful groups, the null hypothesis was rejected. Table 1 shows the results of this discriminant analysis.

After the discriminating variables were obtained, a second discriminant analysis was performed using only those variables that produced a change in Rao's V significant at the 0.10 level. The results are shown in Table 2 and can be summarized as follows:

1. The discriminant analysis arranged the variables in order according to their importance, and the standardized discriminant function coefficients showed the level of contribution relative to each other. Thus, the variable of numerical skills contributed the most and instructional method and age contributed less. Self-assessment of knowledge of mathematics and self-assessment of attitude toward mathematics were of lesser importance as discriminators.
2. The sign of the standardized discriminant function coefficients showed that all the variables were inversely related to the group. Thus, for each of the variables,

the higher the score, the more likely the subject was a member of the group with the lower centroid (successful), and the lower the score, the more likely the subject was a member of the group with the higher centroid (unsuccessful).

3. The canonical correlation was 0.308. The canonical correlation squared, approximately 0.095, indicated that this discriminant analysis explained about 9 percent of the variance.
4. The value of Wilks' lambda at the fifth step was 0.90486. This showed that the degree of separation between the two groups (successful and unsuccessful) was quite small.

Finally, a classification analysis was conducted on the population using the five discriminating variables (see Table 3). The discriminant analysis correctly classified 63 percent (N = 323) of the subjects. To improve the classification, a second classification analysis was used using the prior probabilities of group membership. The prior probabilities were known in that the descriptive analysis showed that 65 percent (N = 334) of the subjects were successful and 35 percent (N = 179) were unsuccessful. This classification analysis correctly classified 69 percent (N = 352) of the subjects (see Table 4).

Discussion

The results of the descriptive and discriminant analyses can

be used to form a composite picture of the successful community college developmental mathematics students in this study. Successful students were more likely to: (1) score higher on an arithmetic achievement test, (2) enroll in a course featuring traditional instruction, (3) be older, (4) assess their mathematical ability higher, and (5) assess their attitude toward mathematics more positively.

However, the cognitive style of field dependence-independence failed to discriminate between the successful and unsuccessful groups. Witkin (1977) has reported that field dependence is a process variable and appears to be unrelated to overall academic achievement. Thus, a plausible explanation for the lack of discriminating ability of cognitive style is that the dependent variable of this study was an achievement variable.

Furthermore, the results indicated that discriminant analysis can be an effective tool to identify variables as potential discriminators for academic achievement. In addition, discriminant analysis can provide data for use in the prediction of success and failure of developmental mathematics students in community colleges. The results have important implications for counsellors and faculty in that they can encourage students to develop their skills and enhance their self-assessments in those areas related to success.

Of interest, is the discriminating ability of instructional method, self-assessment of mathematical ability, and self-assessment of attitude toward mathematics. The literature indicates that

instructional method has not been rigorously tested or defined. In the context of this study, a possible explanation is that the traditional methods provided the organizational framework that was more conducive for completion, and that by their presence, instructors were more able to help students overcome attitudinal and cognitive difficulties. Research has been conducted on the relationship of attitude and performance, but Bleyer (1980) reported that there is no clear indication of a strong relationship. However, this could be due to inadequate measurement. More research is needed so that variables of this type can be rigorously defined and measured.

Finally, this study was able to explain only 9 percent of the variance with the five discriminating variables. Thus, a search for more variables is warranted. In addition, further research is needed to improve the definition and measurement of several of the variables used in this study. This is especially true of the self-assessment variables. Better measurement and definition as well as the inclusion of more variables may increase the percent of variance explained.

Table 1

Discriminant Analysis Data for All Students (N = 513)

Step Number	Variable Entered	Means and Standard Deviations				F Value	Wilks' Lambda	Rao's V	Change in Rao's V	Significance of Change	Standardized Discriminant Function Coefficients
		Successful		Unsuccessful							
		M	SD	M	SD						
1	Numerical Skills	22.37	6.57	19.34	6.05	26.23706	0.95116	26.23869	26.23869	0.000	-0.51993
2	Instructional Method	0.39	0.49	0.54	0.50	9.18862	0.93433	35.91817	9.67947	0.002	-0.40342
3	Age	23.57	8.26	21.39	5.58	7.52127	0.92072	44.00067	8.08250	0.004	-0.41552
4	Self assessment of knowledge of mathematics	2.30	0.85	2.06	0.89	6.22915	0.90957	50.80620	6.80553	0.009	-0.36403
5	Self assessment of attitude toward mathematics	2.95	0.94	2.70	1.01	2.64034	0.90486	53.72939	2.92319	0.087	-0.33841
6	Reason for taking the course	3.74	1.07	3.63	1.12	1.42264	0.90232	55.31651	1.58713	0.208	-0.17692
7	Self assessment of mathematical ability	2.65	0.80	2.51	0.73	1.19496	0.90019	56.65599	1.33948	0.247	0.18292

NOTE: The variables of Cognitive Style and Sex did not produce an $F \geq 1$.

Centroid for successful group = -0.23106;

Centroid for unsuccessful group = 0.48112

Canonical Correlation = 0.316

Table 2

Discriminant Analysis Data for the Entire Group (N = 513)

Step Number	Variable Entered	Means and Standard Deviations				F Value	Wilks' Lambda	Rao's V	Change in Rao's V	Significance of Change	Standardized Discriminant Function Coefficients
		Successful		Unsuccessful							
		M	SD	M	SD						
1	Numerical skills	22.37	6.57	19.34	6.05	26.23706	0.95116	26.23869	26.23869	0.000	-0.51099
2	Instructional method	0.54	0.50	0.39	0.49	9.18862	0.93433	35.91817	9.67947	0.002	-0.42844
3	Age	23.57	8.26	21.39	5.58	7.52127	0.92072	44.00067	8.08250	0.004	-0.42468
4	Self-assessment of knowledge of mathematics	2.30	0.85	2.06	0.89	6.22915	0.90957	50.80620	6.80553	0.009	-0.33760
5	Self-assessment of attitude toward mathematics	2.95	0.94	2.70	1.01	2.64034	0.90486	53.72939	2.923.9	0.087	-0.22858

Canonical Correlation = 0.308

Centroid for Successful Group = -0.22559

Centroid for Unsuccessful Group = 0.42093

Table 3

Classification Results for the Entire Group (N = 513) without Prior Probabilities

Actual Group Membership	Number of Cases	Predicted Group Membership: Successful N	Successful %	Unsuccessful N	Unsuccessful %
Successful	179	119	66.5	60	33.5
Unsuccessful	334	130	38.9	204	61.1

Number of Cases Correctly Classified = 323 Percent of Cases Correctly Classified = 63.0

Table 4

Classification Results for the Entire Group (N = 513) with Prior Probabilities

Actual Group Membership	Number of Cases	Predicted Group Membership			
		Successful		Unsuccessful	
		N	%	N	%
Successful	179	53	29.6	126	70.4
Unsuccessful	334	35	10.5	299	89.5

Number of Cases Correctly Classified = 352 Percent of Cases Correctly Classified = 68.6

References

The ACT Career Planning Program. Iowa City: American College Testing Program, 1976.

Baldwin, J.A. Survey of developmental mathematics courses at colleges in the United States. Community/Junior College Research Quarterly, 1977, 1, 341-353.

Bleyer, D.R. Student's attitudes toward mathematics and their relationship to learning in required mathematics courses in selected post secondary institutions. Community/Junior College Research Quarterly, 1980, 4, 331-347.

Bloomberg, J. An investigation of the relative effectiveness of the basic mathematics review program at Essex Community College. 1971, (ERIC Document Reproduction Service No. ED 062 973).

Corn, J. & Behr, A. A comparison of three methods of teaching remedial mathematics as measured by results in a follow-up course. The MAYTC Journal, 1975, 9, 9-13.

Craig, J. An assessment of the effectiveness of developmental educational programs in selected urban community colleges in the commonwealth of Virginia. Unpublished doctoral dissertation, The Florida State University, 1975.

Dahlke, R.M. Determining the best predictors of success and of time of completion or dropout in an individualized course in arithmetic at a community college. Journal for Research in Mathematics Education, 1974, 5, 213-223.

Edwards, R.R. The prediction of success in remedial mathematics courses in the public community junior college. The Journal of Educational Research, 1972, 66, 157-160.

Gleazer, E.J. This is the community college. New York: Houghton-Mifflin, 1968.

Goodenough, D.R., & Witkin, H.A. Origins of the field-dependent and field-independent cognitive styles (ETS RB 77-9). Princeton, N.J.: Educational Testing Service, 1977.

Helping you explore your options. Iowa City: American College Testing Program, 1977.

Kimes, B.A. A comparison of selected characteristics of developmental mathematics students of Eastfield College. Unpublished doctoral dissertation, East Texas State University, 1973.

Losak, J. Do remedial programs really work? Personnel and Guidance Journal, 1972, 50, 383-385.

Medsker, L. The junior college: progress and prospect. New York: McGraw Hill, 1960.

Monroe, C.R. Profile of the community college. SanFrancisco: Jossey-Bass, 1972.

Moore, W.J. Community college response to the high risk student: a critical reappraisal. Washington, D.C.: American Association of Community and Junior Colleges/Council of Universities and Colleges/ ERIC clearinghouse for junior colleges, 1976.

Oltman, P.K., Raskin, E., & Witkin, H.A. Group embedded figures test. Palo Alto, CA: Consulting Psychologists Press, 1971.

Pepper, J.D. Remedial education at the college level. Community College Frontiers, 1978, 6, 12-17.

Roueche, J.E., & Kirk, R.W. Catching up: remedial education. SanFrancisco: Jossey-Bass, 1977.

Witkin, H.A. A manual for the embedded figures test. Palo Alto CA: Consulting Psychologists Press, 1971.

Witkin, H.A., Friedman, F., Goodenough, D.R., Moore, C.A., Oltman, P.K., Owen, D.R., & Raskin, E. Role of the field-dependent and field-independent cognitive styles in academic evolution: a longitudinal study. Journal of Educational Psychology, 1977, 69, 197-211.

Zwerling, L.S. Developmental math with a difference. Change-Report on Teaching Number 3, 1977, 1, 28-31.